Remarks

Claims 1-8 are pending in the application. Claims 1-8 are rejected. The rejections are traversed.

Claim 1-3 are rejected under 35 USC 102(e) as being anticipated by Bern et al., U.S. Patent 6,384,826.

In order to minimize confusion, it may be helpful to understand and distinguish a Voronoi diagram from a distance field as conventionally defined.

Voronoi Diagram

A Voronoi diagram partitions a plane with n discrete points into n convex polygons such that each polygon contains exactly one discrete point and every point in a given polygon is closer to its central point than to any other. A Voronoi diagram is sometimes also known as a Dirichlet tessellation. The irregular shaped cells are called Dirichlet regions, Thiessen polytopes, or Voronoi polygons, see Bren Figure 2.

Distance Field

A distance field is a mapping $D:\mathfrak{R}^2 \rightarrow \mathfrak{R}$ for all $\mathbf{p} \in \mathfrak{R}^2$, such that $D(\mathbf{p}) = \text{sign}(\mathbf{p}) \cdot \min\{\|\mathbf{p} - \mathbf{q}\|$: for all points $\mathbf{q}$ on the zero-valued iso-surface, i.e., edge, of $S\}$, $\text{sign}(\mathbf{p}) = \{$ -1 if $\mathbf{p}$ is outside S, +1 if $\mathbf{p}$ is inside $S\}$, and $\|$, where $\|$ is the Euclidean norm. For the layman, the distance field measures a minimum continuous distance from any point $\mathbf{p}$ to an object surface, where the sign of the continuous distance is *negative* if the point $\mathbf{p}$ is *outside* the surface and *positive* if the point $\mathbf{p}$ is *inside* the object's surface. Points *on* the surface have a *zero* distance value. Prior art distance fields are regularly sampled, whereas the adaptive distance field according to the invention is irregularly sampled at a rate that is proportional to the gradient of the distance field at any given sample point. In 2D, distance values are typically stored as a hierarchy of square cells, with the cell size also dependent on the gradient of the distance field. Usually, the distance values are stored at the corners of the cells.

There is no relationship between the Voronoi diagram as used by Bern and the adaptively sampled distance field according to the invention. Those of ordinary skill in the art would understand that Voronoi diagrams and distance fields are two unrelated fields.

From the Bern Summary, at column 2, lines 15-33, A surface is reconstructed by first generating the Voronoi diagram for discrete sample points. The Voronoi diagram represents a division of space into Voronoi cells, one Voronoi cell for each sample point, such that each sample point's Voronoi cell consists of that part of space closer to it than to any other sample point. The surface reconstruction system uses the sample points and the shapes of their Voronoi irregularly shaped cells to determine which surface triangles to include in the reconstructed surface. Voronoi cell shape information includes locations of vertices, angles at vertices and edges, aspect ratio of the cell, and directions and lengths of principal axes of the cell.

In contrast, as claimed, the invention converts an adaptively sampled distance field of a graphics model to a triangle model. The invention begins with an adaptively sampled distance field (not samples) storing continuous distance values in surface cells having corresponding gradients. Bren does not describe any type of distance field, as defined classically above, nor surface cells, nor gradients of distance values. Bren does no assign a vertex to a center location of each surface cell. Bren does not connect vertices of neighboring surface cells to form triangles while satisfying a predetermined constraint, and Bren does not move each vertex, in a single step, to a new location according to the distance value and corresponding gradient of the vertex to substantially conform the triangles to a surface of a model.

MPEP 2131 explicitly states that in order to anticipate a claim "each and every element as set forth in the claims" must be found in the prior art reference. "The identical invention must be shown in as complete detail as is contained in the ... claim." Bren cannot anticipate what is claimed. Bren does not have a single element of what is claimed. First, Bren only uses Voronoi diagram, see Bern, column 2, lines 13-55. Second, Bren begins with discrete sample points, not continuous distance values. Third, Bren does not move vertices at the center of adaptively sampled distance cells.

According to claim 2, each surface cell has edges connecting corners of the cells, and some neighboring surface cells have common edges and a predetermined constraint that *only* connects vertices in three neighboring surface cells having common edges, and at least one common edge intersects the surface of the graphics model. As explained above, the irregular Dirichlet regions or Voronoi cells of Bren have nothing to do with square hierarchical distance field cells.

According to claim 3, an orientation for each triangle is derived from an orientation of the at least one common edge intersecting the surface. There are no columns 19-30 (sic) in Bren. Applicants have studied all columns at line 19-30, to see if the Examiner's remark is a typographical error, but still cannot find an orientation as claimed. The only orientation in Bren is an orientation of triangles that is first "inside" and then "outside" according to a breadth-first search and "poles."

Claim 4-8 are rejected under 35 USC 103(a) as being unpatentable over Bren et al., in view of Assa et al., U.S. Patent 6,313,837.

Assa describes a method for representing a surface at multiple levels of resolution. The surface is partitioned into nodes with one or more boundaries, each level of resolution having a subset of the boundaries. Another surface may be classified against the first surface. Surfaces and the model may be decimated. Portions of the surfaces may be loaded from persistent memory on demand and removed when no longer required.

According to claim 4, less than all common edges of a particular surface cell are considered when connecting vertices. Assa represents a surface with a grid cell structure. Therefore, Assa constructs a hybrid grid-mesh because areas of the grid can be dynamically converted to mesh. Figure 20a-b shows a grid cell with two possible triangulations 190 and 192, as shown in FIGS. 20a-b.

First, the grid cell mesh cannot be combined with the Voronoi cells of Bren. These two representations are incompatible. Those of ordinary skill in the art would not know how to combine Assa with Bern. Second, the grid cells represent a surface, whereas the cells as claimed are used for an adaptively sampled distance field. Neither Assa, or Assa in combination with Bern

know anything about adaptively sampled distance field. Therefore, both of their teachings are not applicable to what is claimed.

According to claim 5, the claimed method considers edges connect to two diagonally opposing corners of the surface cell, see above.

According to claim 6, the adaptively sampled distance field includes a root surface cell, intermediate surface cells, and leaf surface cells arranged in layers of a hierarchical tree, and wherein vertices are assigned only to leaf cells. Neither Bern nor Assa teach adaptively sampled distance fields represented by a hierarchy of cells.

According to claim 7, the adaptively sampled distance field includes a root surface cell, intermediate surface cells, and leaf surface cells arranged in layers of a hierarchical tree, and wherein vertices are assigned to all surface cells up to a predetermined level in the hierarchical tree. Neither Bern nor Assa teach adaptively sampled distance fields represented by a hierarchy of cells.

According to claim 8, the adaptively sampled distance field includes a root surface cell, intermediate surface cells, and leaf surface cells arranged in layers of a hierarchical tree, and each cell has an associated error measure, and the vertices are assigned to cells having a particular error measure less than a predetermined threshold. Neither Bern nor Assa teach adaptively sampled distance fields represented by a hierarchy of cells. Applicants cannot find any assignment of an error measure to cells of a distance field at column 2, lines 10-60, column 21, lines 1-10 in Assa. Applicants respectfully request the Examiner to indicate which words there are believed to mean an "error measure" assigned to a cell of an "adaptively sampled distance field," or if those words cannot be found to withdraw the rejection.

The rejection by the Examiner is a mere conclusion, without a full development of reasons. These assertions are nothing more that an omnibus rejection and provide no reasonable level of understanding of the basis for the Examiner's position. As recognized in MPEP 707.07(d), "omnibus rejection of the claim ...is usually not informative and should therefore be avoided." Applicants request the Examiner provide some understandable reason for the rejection.

In short, Bren and Assa do not teach how to convert a distance field to triangles. Neither reference has anything to do with distance fields.

All rejections have been complied with, and applicant respectfully submits that the application is now in condition for allowance. The applicant urges the Examiner to contact the applicant's attorney at phone and address indicated below if assistance is required to move the present application to allowance. Please charge any shortages in fees in connection with this filing to Deposit Account 50-0749.

Respectfully submitted,

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